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Supramolecular Peptide Nanofiber Morphology Affects Mechanotransduction of Stem Cells

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Abstract

© 2017 American Chemical Society. Chirality and morphology are essential factors for protein function and interactions with other biomacromolecules. Extracellular matrix (ECM) proteins are also similar to other proteins in this sense; however, the complexity of the natural ECM makes it difficult to study these factors at the cellular level. The synthetic peptide nanomaterials harbor great promise in mimicking specific ECM molecules as model systems. In this work, we demonstrate that mechanosensory responses of stem cells are directly regulated by the chirality and morphology of ECM-mimetic peptide nanofibers with strictly controlled characteristics. Structural signals presented on l-amino acid containing cylindrical nanofibers (l-VV) favored the formation of integrin β1-based focal adhesion complexes, which increased the osteogenic potential of stem cells through the activation of nuclear YAP. On the other hand, twisted ribbon-like nanofibers (l-FF and d-FF) guided the cells into round shapes and decreased the formation of focal adhesion complexes, which resulted in the confinement of YAP proteins in the cytosol and a corresponding decrease in osteogenic potential. Interestingly, the d-form of twisted-ribbon like nanofibers (d-FF) increased the chondrogenic potential of stem cells more than their l-form (l-FF). Our results provide new insights into the importance and relevance of morphology and chirality of nanomaterials in their interactions with cells and reveal that precise control over the chemical and physical properties of nanostructures can affect stem cell fate even without the incorporation of specific epitopes.

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